IEEE P802.11
Wireless LANs

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| **Update on Proposed Draft Text of ‘Pilots’ section in PHY** |
| **Date:** 2020-11-18 |
| **Author(s):** |
| **Name** | **Affiliation** | **Address** | **Phone** | **email** |
| Jinyoung Chun | LG Electronics |  |  | jiny.chun@lge.com |
| Eunsung Park | LG Electronics |  |  |  |
| Dongguk Lim | LG Electronics |  |  |  |
| Jinsoo Choi | LG Electronics |  |  |  |

Abstract

This document is proposed draft text of ‘pilots’ section in PHY

r0: initial draft

r1: text update on 1x LTF

r2: 26-tone RU index change (it depends on the result of 11-20/1845r2 SP1 which suggests new 26-tone RU indices)

r3: editorial change (mod 8 to mod 6 in 26+52 / 26+106-tone RU)

r4: typo fixing

r5: reflect a comment by Ron

# Introduction

This submission proposes the draft text on Pilot for 802.11be D0.2. This document is based on the following motions in ‘802.11-20/0566r94 Compendium of Stras Polls and Potential Changes to the Specification Framework Document’.

For small multi-RUs 106+26 and 52+26, a modulo 6 is used for the pilot polarity rotation.

P*n*= {Ψ(*n*) mod 6, Ψ(*n*+1) mod 6, Ψ(*n*+2) mod 6, Ψ(*n*+3) mod 6, Ψ(*n*+4) mod 6, Ψ(*n*+5) mod 6}

[Motion 137, #SP273, [3] and [126]]

The 6 initial pilot values for 52+26 and 106+26 multi-RU are given as follows:

ψ0= 1, ψ1= 1, ψ2= 1, ψ3= -1, ψ4= -1, ψ5= 1.

[Motion 137, #SP274, [3] and [126]]

~~Red strike-out text~~ is proposed to delete.

Blue underlined text is proposed to add.

# Proposed text

### 36.3.2.4 Pilot subcarriers

Pilot subcarriers are present in the Data field, and may be present in the EHT-LTF field.

The pilot subcarrier indices for the Data field OFDM symbols are defined in 1.z.x (Pilot subcarriers).

One of three EHT-LTF types is used in the EHT-LTF field of an EHT PPDU: 1x EHT-LTF, 2x EHT-LTF and 4x EHT-LTF. If pilot subcarriers are present in the EHT-LTF field of an EHT PPDU, then, for a 4x EHT-LTF and 2x EHT-LTF, the pilot subcarrier locations in the EHT-LTF field are the same as the pilot subcarrier locations in the Data field. ~~For a 1x EHT-LTF, the pilot subcarrier locations in the EHT-LTF field are the pilot subcarriers locations in the Data field that are multiples of 4.~~

### 36.3.12.8 Pilot subcarriers

For a user transmitting on the *i*-th 26/52/106/242/484-tone RU in a 20/40MHz PPDU BW, the pilot subcarriers defined in 27.3.12.13 (Pilot subcarriers) shall be followed.

For a user transmitting on the *i*-th 26-tone RU in 80/160/320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R26\_{i}}$, where $K\_{R26\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table 36-34 (Pilot indices for a 26-tone RU transmission).

**Table 36-34 - Pilot indices for a 26-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$K\_{R26\_{i}}$$ |
| 80MHz, *i* = 1:~~36~~ 37 |  {-494, -480}, {-468, -454}, {-440, -426}, {-414, -400}, {-386, -372}, {-360, -346}, {-334, -320}, {-306, -292}, {-280, -266}, {-246, -232}, {-220, -206}, {-192, -178}, {-166, -152}, {-140, -126}, {-112, -98}, {-86, -72}, {-58, -44}, {-32, -18}, {not defined}, {18, 32}, {44, 58}, {72, 86}, {98, 112}, {126, 140}, {152, 166}, {178, 192}, {206, 220}, {232, 246}, {266, 280}, {292, 306}, {320, 334}, {346, 360}, {372, 386}, {400, 414}, {426, 440}, {454, 468}, {480, 494} |
| 160MHz, $i=1: 72$ 74 | {pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512} |
| 320MHz , $i=1: 144$ 148 | ~~{pilot subcarrier indices in 80MHz-1536, pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512, pilot subcarrier indices in 80MHz+1536}~~{pilot subcarrier indices in 160MHz-1024, pilot subcarrier indices in 160MHz+1024} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in from Equation (27-101) in 27.3.12.13 (Pilot subcarriers).

For a user transmitting on the *i*-th 52-tone RU in 80/160/320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R52\_{i}}$, where $K\_{R52\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table 36-35 (Pilot indices for a 52-tone RU transmission).

**Table 36-35 - Pilot indices for a 52-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$K\_{R52\_{i}}$$ |
| 80MHz, *i* = 1:16 | {-494, -480, -468, -454}, {-440, -426, -414, -400}, {-360, -346, -334, -320}, {-306, -292, -280, -266}, {-246, -232, -220, -206}, {-192, -178, -166, -152}, {-112, -98, -86, -72}, {-58, -44, -32, -18}, {18, 32, 44, 58}, {72, 86, 98, 112}, {152, 166, 178, 192}, {206, 220, 232, 246}, {266, 280, 292, 306}, {320, 334, 346, 360}, {400, 414, 426, 440}, {454, 468, 480, 494} |
| 160MHz, $i=1: 32$  | {pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512} |
| 320MHz, $i=1: 72$ | ~~{pilot subcarrier indices in 80MHz-1536, pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512, pilot subcarrier indices in 80MHz+1536}~~{pilot subcarrier indices in 160MHz-1024, pilot subcarrier indices in 160MHz+1024} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in from Equation (27-102) in 27.3.12.13 (Pilot subcarriers).

For a user transmitting on the *i*-th 106-tone RU in 80/160/320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R106\_{i}}$, where $K\_{R106\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table 36-36 (Pilot indices for a 106-tone RU transmission).

**Table 36-36 - Pilot indices for a 106-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$K\_{R106\_{i}}$$ |
| 80MHz, *i* = 1:8 | {-494, -468, -426, -400}, {-360, -334, -292, -266}, {-246, -220, -178, -152}, {-112, -86, -44, -18}, {18, 44, 86, 112}, {152, 178, 220, 246}, {266, 292, 334, 360}, {400, 426, 468, 494} |
| 160MHz, $i=1: 16$ | {pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512} |
| 320MHz , $i=1: 32$ | {pilot subcarrier indices in 160MHz-1024, pilot subcarrier indices in 160MHz+1024} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in from Equation (27-103) in 27.3.12.13 (Pilot subcarriers).

For a user transmitting on the *i*-th 242-tone RU in 80/160/320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R242\_{i}}$, where $K\_{R242\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table 36-37 (Pilot indices for a 242-tone RU transmission).

**Table 36-37 - Pilot indices for a 242-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$K\_{R242\_{i}}$$ |
| 80MHz, *i* = 1:4 | {-494, -468, -426, -400, -360, -334, -292, -266}, {-246, -220, -178, -152, -112, -86, -44, -18}, {18, 44, 86, 112, 152, 178, 220, 246}, {266, 292, 334, 360, 400, 426, 468, 494} |
| 160MHz, $i=1: 8$  | {pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512} |
| 320MHz, $i=1: 16$ | {pilot subcarrier indices in 160MHz-1024, pilot subcarrier indices in 160MHz+1024} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in from Equation (27-104) in 27.3.12.13 (Pilot subcarriers).

For a user transmitting on the *i*-th 484-tone RU in 80/160/320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R484\_{i}}$, where $K\_{R484\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table 36-38 (Pilot indices for a 484-tone RU transmission).

**Table 36-38 - Pilot indices for a 484-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$K\_{R484\_{i}}$$ |
| 80MHz, *i* = 1:2 | {-494, -468, -426, -400, -360, -334, -292, -266, -246, -220, -178, -152, -112, -86, -44, -18}, {18, 44, 86, 112, 152, 178, 220, 246, 266, 292, 334, 360, 400, 426, 468, 494} |
| 160MHz, $i=1: 4$  | {pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512} |
| 320MHz, $i=1: 8$ | {pilot subcarrier indices in 160MHz-1024, pilot subcarrier indices in 160MHz+1024} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in from Equation (27-105) in 27.3.12.13 (Pilot subcarriers).

For a user transmitting on the *i*-th 996-tone RU in 80/160/320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R996\_{i}}$, where $K\_{R996\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table 38-39 (Pilot indices for a 996-tone RU transmission).

**Table 36-39 - Pilot indices for a 996-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$K\_{R996\_{i}}$$ |
| 80MHz, *i* = 1 | {-468, -400, -334, -266, -220, -152, -86, -18, 18, 86, 152, 220, 266, 334, 400, 468} |
| 160MHz, *i* = 1:2 | {pilot subcarrier indices in 80MHz-512}, {pilot subcarrier indices in 80MHz+512} |
| 320MHz, *i* = 1:4 | ~~{pilot subcarrier indices in 80MHz-1536, pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512, pilot subcarrier indices in 80MHz+1536}~~{pilot subcarrier indices in 160MHz-1024, pilot subcarrier indices in 160MHz+1024} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in Equation (27-106) in 27.3.12.13 (Pilot subcarriers).

For a user transmitting on the *i*-th 2$×$996-tone RU in 160/320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R2×996\_{i}}$, where $K\_{R2×996\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table 36-40 (Pilot indices for a 2\*996-tone RU transmission).

**Table 36-40 - Pilot indices for a 2**$×$**996-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$K\_{R2×996\_{i}}$$ |
| 160MHz, *i* = 1 | {-980, -912, -846, -778, -732, -664, -598, -530, -494, -426, -360, -292, -246, -178, -112, -44, 44, 112, 178, 246, 292, 360, 426, 494, 530, 598, 664, 732, 778, 846, 912, 980} |
| 320MHz, *i* = 1:2 | {pilot subcarrier indices in 160MHz-1024}, {pilot subcarrier indices in 160MHz+1024} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in Equation (27-107) in 27.3.12.13 (Pilot subcarriers).

For a user transmitting on the *i*-th 4$×$996-tone RU in 320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R4×996\_{i}}$, where $K\_{R4×996\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table 36-41 (Pilot indices for a 4$×$996-tone RU transmission).

**Table 36-41 - Pilot indices for a 4**$×$**996-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$K\_{R4×996\_{i}}$$ |
| 320MHz, *i* = 1 | {-2004, -1936, -1870, -1802, -1756, -1688, -1622, -1554, -1518, -1450, -1384, -1316, -1270, -1202, -1136, -1068, -980, -912, -846, -778, -732, -664, -598, -530, -494, -426, -360, -292, -246, -178, -112, -44, 44, 112, 178, 246, 292, 360, 426, 494, 530, 598, 664, 732, 778, 846, 912, 980, 1068, 1136, 1202, 1270, 1316, 1384, 1450, 1518, 1554, 1622, 1688, 1756, 1802, 1870, 1936, 2004} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in Equation (36-72) and Equation (36-73).

$$P\_{n}^{K\_{R4×996\_{i}}}=\{Ψ\_{n mod 8}, Ψ\_{\left(n+1\right)mod 8}, Ψ\_{\left(n+2\right)mod 8}, , Ψ\_{\left(n+3\right)mod 8}, $$

$$Ψ\_{\left(n+4\right)mod 8}, Ψ\_{\left(n+5\right)mod 8}, Ψ\_{\left(n+6\right)mod 8}, Ψ\_{\left(n+7\right)mod 8}, $$

$$Ψ\_{\left(n+8\right)mod 8}, Ψ\_{\left(n+9\right)mod 8}, , Ψ\_{\left(n+10\right)mod 8}, Ψ\_{\left(n+11\right)mod 8}, $$

$$Ψ\_{\left(n+12\right)mod 8}, Ψ\_{\left(n+13\right)mod 8}, Ψ\_{\left(n+14\right)mod 8}, Ψ\_{\left(n+15\right)mod 8}, $$

$$Ψ\_{n mod 8}, Ψ\_{\left(n+1\right)mod 8}, Ψ\_{\left(n+2\right)mod 8}, , Ψ\_{\left(n+3\right)mod 8}, $$

$$Ψ\_{\left(n+4\right)mod 8}, Ψ\_{\left(n+5\right)mod 8}, Ψ\_{\left(n+6\right)mod 8}, Ψ\_{\left(n+7\right)mod 8}, $$

$$Ψ\_{\left(n+8\right)mod 8}, Ψ\_{\left(n+9\right)mod 8}, , Ψ\_{\left(n+10\right)mod 8}, Ψ\_{\left(n+11\right)mod 8}, $$

$Ψ\_{\left(n+12\right)mod 8}, Ψ\_{\left(n+13\right)mod 8}, Ψ\_{\left(n+14\right)mod 8}, Ψ\_{\left(n+15\right)mod 8}, $ (36-72)

$$Ψ\_{n mod 8}, Ψ\_{\left(n+1\right)mod 8}, Ψ\_{\left(n+2\right)mod 8}, , Ψ\_{\left(n+3\right)mod 8}, $$

$$Ψ\_{\left(n+4\right)mod 8}, Ψ\_{\left(n+5\right)mod 8}, Ψ\_{\left(n+6\right)mod 8}, Ψ\_{\left(n+7\right)mod 8}, $$

$$Ψ\_{\left(n+8\right)mod 8}, Ψ\_{\left(n+9\right)mod 8}, , Ψ\_{\left(n+10\right)mod 8}, Ψ\_{\left(n+11\right)mod 8}, $$

$$Ψ\_{\left(n+12\right)mod 8}, Ψ\_{\left(n+13\right)mod 8}, Ψ\_{\left(n+14\right)mod 8}, Ψ\_{\left(n+15\right)mod 8}, $$

$$Ψ\_{n mod 8}, Ψ\_{\left(n+1\right)mod 8}, Ψ\_{\left(n+2\right)mod 8}, , Ψ\_{\left(n+3\right)mod 8}, $$

$$Ψ\_{\left(n+4\right)mod 8}, Ψ\_{\left(n+5\right)mod 8}, Ψ\_{\left(n+6\right)mod 8}, Ψ\_{\left(n+7\right)mod 8}, $$

$$Ψ\_{\left(n+8\right)mod 8}, Ψ\_{\left(n+9\right)mod 8}, , Ψ\_{\left(n+10\right)mod 8}, Ψ\_{\left(n+11\right)mod 8}, $$

$$Ψ\_{\left(n+12\right)mod 8}, Ψ\_{\left(n+13\right)mod 8}, Ψ\_{\left(n+14\right)mod 8}, Ψ\_{\left(n+15\right)mod 8}\} $$

$P\_{n}^{k\notin K\_{R4×996\_{i}}}=0 $ (36-73)

where

$Ψ\_{m}$ is defiend in Table 27-43 (The 8 pilot values in a 242-tone RU)

~~For a noncontiguous 160+160 MHz transmission, each 160MHz frequency segment shall follow the pilot sub-carrier allocation and values defined for 2\*996-tone RU in 160MHz transmission.~~

For a user transmitting on the MRUs, the pilot subcarriers, mapping and values of MRUs shall follows the pilot subcarriers, mapping and values of each ~~RU~~ component RU of the MRU except the below pilot mapping.

For a user transmitting on the 52+26-tone RU and 106+26-tone RU, the pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in from Equation (36-xx) to Equation (36-bb).

$P\_{n}^{K\_{R26+52\_{i}}}=\{Ψ\_{n mod 6}, Ψ\_{\left(n+1\right)mod 6}, Ψ\_{\left(n+2\right)mod 6}, Ψ\_{\left(n+3\right)mod 6},Ψ\_{\left(n+4\right)mod 6},Ψ\_{\left(n+5\right)mod 6}\} $ (36-xx)

$P\_{n}^{k\notin K\_{R26+52\_{i}}}=0 $ (36-yy)

$P\_{n}^{K\_{R26+106\_{i}}}=\{Ψ\_{n mod 6}, Ψ\_{\left(n+1\right)mod 6}, Ψ\_{\left(n+2\right)mod 6}, Ψ\_{\left(n+3\right)mod 6},Ψ\_{\left(n+4\right)mod 6},Ψ\_{\left(n+5\right)mod 6}\} $ (36-zz)

$P\_{n}^{k\notin K\_{R26+106\_{i}}}=0 $ (36-aa)

Where

$Ψ\_{0}=1, Ψ\_{1}=1,Ψ\_{2}=1,Ψ\_{3}=-1,Ψ\_{4}=-1,Ψ\_{5}=1 $ (36-bb)

The above pilot mapping shall be copied to all space-time streams before the space-time stream cyclic shifts are applied.